

CLAIMS

We claim:

1. A method of creating a profile-based simulation data store for an integrated circuit utilizing one or more simulations, the method comprising:

simulating one or more fabrication processes using a selected set of process control parameters, the fabrication process simulations generating fabrication attributes;

generating calculated signals with a metrology simulator, the metrology simulator using profile data from the fabrication attributes, the profile data comprising profile shapes and critical dimensions of structures resulting from the one or more fabrication process simulations; and

creating simulation data store instances, the instances including profile data and corresponding calculated signals, simulation types, and associated process control parameters and fabrication attributes;

wherein the simulation types are characterizations of the one or more simulations performed.

2. The method of Claim 1 wherein simulating one or more fabrication processes comprises:

simulating a thin film, deposition or chemical mechanical polishing process using a selected first set of process control parameters; and

simulating lithography process using a selected second set of process control parameters.

3. The method of Claim 1 wherein simulating one or more fabrication processes comprises:

simulating a lithography process using a selected first set of process control parameters;
and

simulating an etch process using a selected second set of process control parameters.

4. The method of Claim 1 wherein simulating one or more fabrication processes comprises:

simulating a lithography process using a selected first set of process control parameters;
and

simulating an implantation process using a selected second set of process control parameters.

5. The method of Claim 1 wherein simulating one or more fabrication processes comprises:

simulating an etch process using a selected first set of process control parameters; and

simulating a photoresist stripping process using a selected second set of process control parameters.

6. The method of Claim 1 wherein simulating one or more fabrication processes comprises:

simulating an implantation process using a selected first set of process control parameters; and

simulating a photoresist stripping process using a selected second set of process control parameters.

7. A method of creating a profile-based simulation data store for an integrated circuit utilizing one or more simulations, the method comprising:

simulating one or more devices using a selected set of input parameters, the device simulations generating device attributes, the set of input parameters including profile data corresponding to the one or more simulated devices;

generating calculated signals with a metrology simulator, the metrology simulator using profile data corresponding to the one or more simulated devices; and

creating simulation data store instances, the instances including profile data and corresponding calculated signals, simulation types, process control parameters, and fabrication attributes;

wherein the simulation types are characterizations of the one or more simulations performed.

8. The method of Claim 7 wherein the selected set of input parameters comprises a profile library having profile data, the profile data including profiles of the one or more devices simulated.

9. A method of creating a profile-based simulation data store for an integrated circuit utilizing one or more simulations, the method comprising:

simulating one or more circuits using a selected set of input parameters, a circuit having one or more devices, the circuit simulations generating circuit attributes, the set of input parameters including profile data corresponding to the one or more devices of the simulated one or more circuits;

generating calculated signals with a metrology simulator, the metrology simulator using profile data corresponding to the one or more devices of the simulated one or more circuits; and

creating simulation data store instances, the instances including calculated signals, profile data, simulation types, process control parameters, and circuit attributes;

wherein the simulation types are characterizations of the one or more simulations performed.

10. The method of Claim 9 wherein the one or more circuits simulated include transmission lines, resistors, capacitors, inductors, amplifiers, switches, diodes, or transistors.

11. A method of creating a profile-based simulation data store for an integrated circuit utilizing one or more simulations, the method comprising:

simulating one or more fabrication processes using a selected set of process control parameters, the fabrication process simulations generating fabrication attributes;

generating calculated signals with a metrology simulator, the metrology simulator using profile data from the generated fabrication attributes, the profile data comprising profile shapes and critical dimensions of structures resulting from the one or more fabrication process simulations;

simulating one or more devices using profile data generated by the one or more simulated fabrication processes; and

creating simulation data store instances, the instances including profile data from the generated fabrication attributes, corresponding calculated signals, simulation types and associated process control parameters and device attributes;

wherein the simulation types are characterizations of the one or more simulations performed.

12. The method of Claim 11 wherein the one or more fabrication processes simulated include a lithography simulation and an etch simulation and wherein the one or more device simulations include an interconnect simulation.

13. A method of creating a profile-based simulation data store for an integrated circuit, the method comprising:

simulating one or more devices using a selected set of input parameters, the device simulations generating device attributes, the set of input parameters including profile data of the one or more simulated devices;

generating calculated signals with a metrology simulator, the metrology simulator using profile data of the one or more simulated devices;

simulating one or more circuits using the generated device attributes from the one or more device simulations as input parameters, the circuit simulations generating circuit attributes; and

creating simulation data store instances, the instances including profile data and corresponding calculated signals, simulation types and associated input parameters, device attributes, and circuit attributes;

wherein the simulation types are characterizations of the one or more simulations performed.

14. The method of Claim 13 wherein the one or more device simulations include a power device simulation and an interconnect simulation.

15. The method of Claim 13 wherein the one or more circuit simulations include a transmission line simulation and an amplifier simulation.

16. A method of creating a profile-based simulation data store for an integrated circuit utilizing one or more simulations, the method comprising:

simulating one or more fabrication processes using a selected set of process control parameters, the fabrication process simulations generating fabrication attributes;

generating calculated signals with a metrology simulator, the metrology simulator using profile data from the generated fabrication attributes, the profile data comprising profile shapes and critical dimensions of structures resulting from the one or more fabrication process simulations;

simulating one or more devices using profile data generated by the one or more simulated fabrication processes;

simulating one or more circuits using the generated device attributes from the one or more device simulations as input parameters, the circuit simulations generating circuit attributes; and

creating simulation data store instances, the instances including profile data, corresponding calculated signals, simulation types, and associated process control parameters, fabrication attributes, device attributes, and circuit attributes;

wherein the simulation types are characterizations of the one or more simulations performed.

17. The method of Claim 16 wherein the one or more fabrication process simulations include a lithography simulation, the one or more device simulation includes an interconnect simulation, and the one or more circuit simulation include a transmission line simulation.

18. A method of creating a profile-based simulation data store for an integrated circuit, the method comprising:

measuring one or more test gratings with a metrology device wherein the test gratings model the effect of an integrated circuit design and/or fabrication process;

generating measured signals with the metrology device;

converting the measured signals into profile data corresponding to the measured test gratings;

simulating one or more devices using the converted profile data as a set of input parameters, the device simulations generating device attributes; and

creating simulation data store instances, the instances including profile data, corresponding measured signals, simulation types, and associated device attributes;

wherein the simulation types are characterizations of the one or more simulations performed.

19. The method of Claim 18 wherein converting the measured signals into process control parameters further comprises:

comparing the measured signals off the test gratings to instances of a library of calculated signals, the instances of the library of calculated signals having data elements comprising calculated signals and profile data;

selecting corresponding best matching instances in the library of calculated signals; and

accessing profile data from the selected best matching instances of the library of calculated signals.

20. The method of Claim 18 wherein the one or more device simulations are interconnect simulations.

21. The method of Claim 18 wherein measuring the test grating further comprises:

designing the test gratings to capture interconnect geometric configurations of the integrated circuit;

fabricating the designed test gratings; and

measuring the fabricated test gratings with the metrology device.

22. The method of Claim 18 wherein the device attributes include resistance, inductance, capacitance, potential, temperature, and current density distribution of the interconnect.

23. A method of real-time use of simulation data store, the method comprising:

measuring a grating with a metrology device, the grating modeling an interconnect geometry of an integrated circuit, the measurement generating a measured signal; and

obtaining interconnect electrical properties and/or thermal properties corresponding to the measured signal off the grating.

24. The method of Claim 23 wherein obtaining interconnect electrical properties and/or thermal properties corresponding to the measured signal off the grating further comprises:

accessing a simulation data store, the simulated data store storing instances having data elements comprising signals and device attributes, the device attributes including interconnect electrical properties and/or thermal properties;

comparing the measured signal to the signals in the instances of the simulation data store;

selecting a best matching instance of the simulation data store; and

accessing the interconnect electrical properties and/or thermal properties associated with the best matching instance of the simulated data store.

25. The method of Claim 23 wherein the interconnect electrical properties include capacitance, inductance, and resistance.

26. A method of creating a profile-based simulation data store for an integrated circuit utilizing a metrology simulator, the method comprising:

performing fabrication process simulations using a set of process control parameters, the fabrication process simulations generating a set of fabrication attributes and a set of structure profile data;

calculating a set of simulated signals corresponding to the set of structure profile data using a metrology simulator; and

creating instances of a simulation data store, each instance of the simulation data store having data elements comprising profile data and corresponding calculated signals, simulation types, and associated process control parameters and fabrication attributes;

wherein the simulation types are characterizations of the simulations performed.

27. The method of Claim 26 wherein the fabrication process simulation is a lithography simulation.

28. The method of Claim 26 wherein the fabrication process simulation is a combined lithography and etch simulation.

29. The method of Claim 26 wherein the fabrication process simulation is an implantation simulation, diffusion simulation, oxidation simulation, deposition and etching simulation, chemical mechanical polishing simulation, deposition and reflow simulation, 2-dimensional process simulation, or 3-dimensional fabrication process simulation.

30. The method of Claim 26 wherein the metrology simulator is an optical metrology simulator.

31. A system for creating a profile-based simulation data store for an integrated circuit, the system comprising:

a profiler application server configured to:

compare a measured signal off a test grating in a wafer to calculated signals in instances of a calculated signals library, the library instances storing data elements comprising calculated signals and profile data, and

select a best matching instance of the library of calculated signals;

a fabrication process simulator configured to:

simulate one or more fabrication processes, and

generate fabrication attributes utilizing profile data associated with the best matching instance of the library of calculated signals; and

a simulation data store generator configured to:

create an instance of a simulation data store, the simulation data store instance storing data elements comprising the profile data, associated measured signals, simulation types, and the associated fabrication attributes;

wherein the simulation types are characterizations of the one or more fabrication processes simulations performed.

32. A system for creating a profile-based simulation data store for an integrated circuit, the system comprising:

a profiler application server configured to:

compare a measured signal off a test grating in a wafer to calculated signals in instances of a calculated signals library, the library instances storing data elements comprising profile data and associated calculated signals, and

select a best matching instance of the library of calculated signals;

a device simulator configured to:

simulate one or more devices, and

generate device attributes utilizing profile data associated with the best matching instance of the library of calculated signals; and

a simulation data store generator configured to:

create an instance of a simulation data store, the simulation data store instance storing data elements comprising the profile data, associated measured signals, simulation types, and associated device attributes;

wherein the simulation types are characterizations of the one or more device simulations performed.

33. A system for creating a profile-based simulation data store for an integrated circuit, the system comprising:

a profiler application server configured to:

compare a measured signal off a test grating in a wafer to calculated signals in instances of a calculated signals library, the library instances storing data elements comprising profile data and associated calculated signals, and

select a best matching instance of the library of calculated signals;

a device simulator configured to:

simulate one or more circuits, and

generate circuit attributes utilizing profile data associated with the best matching instance of the library of calculated signals; and

a simulation data store generator configured to:

create an instance of a simulation data store, the simulation data store instance storing data elements comprising the profile data, associated measured signals, simulation types, and associated circuit attributes;

wherein the simulation types are characterizations of the one or more circuit simulations performed.

34. A system for creating a profile-based simulation data store for an integrated circuit, the system comprising:

a fabrication process simulator configured to:

simulate one or more fabrication processes using a selected set of process control parameters, the fabrication process simulations generating fabrication attributes, the fabrication attributes including structure profile data;

a metrology simulator configured to:

receive the structure profile data from the fabrication process simulator,
and

generate calculated metrology signals using a simulated grating, the simulated grating having a repeating structure with the same profile data as the received structure profile data;

a simulation data store generator configured to:

create instances of a simulation data store, each simulation data store instance storing data elements comprising the profile data, associated calculated signals, simulation types, and associated process control parameters and fabrication attributes;

wherein the simulation types are characterizations of the one or more fabrication process simulations performed.

35. A system for creating a profile-based simulation data store for an integrated circuit, the system comprising:

a fabrication process simulator configured to:

simulate one or more fabrication processes using a selected set of process control parameters, the fabrication process simulations generating fabrication attributes, the generated fabrication attributes including structure profile data;

a metrology simulator configured to:

receive the structure profile data from the fabrication process simulator, and

generate calculated metrology signals using a simulated grating, the simulated grating having a repeating structure with the same profile data as the received structure profile data;

a device simulator configured to:

simulate one or more devices using the profile data from the generated fabrication attributes;

a simulation data store generator configured to:

create instances of a simulation data store, each simulation data store instance storing data elements comprising the profile data, associated measured signals, simulation types, and associated process control parameters, fabrication attributes, and device attributes;

wherein the simulation types are characterizations of the one or more fabrication or device simulations performed.

36. A system for creating a profile-based simulation data store for an integrated circuit, the system comprising:

a fabrication process simulator configured to:

simulate one or more fabrication processes using a selected set of process control parameters, the fabrication process simulations generating fabrication attributes, the generated fabrication attributes including structure profile data;

a metrology simulator configured to:

receive the structure profile data from the fabrication process simulator, and

generate calculated metrology signals off simulated gratings, the simulated gratings having a repeating structure with the same profile data as the corresponding received structure profile data;

a device simulator configured to:

simulate one or more devices using the profile data from the generated fabrication attributes, the one or more device simulations generating device attributes;

a circuit simulator configured to:

simulate one or more circuits using the generated device attributes from the one or more device simulations as input parameters, the one or more circuit simulations generating circuit attributes;

a simulation data store generator configured to:

create instances of a simulation data store, each simulation data store instance storing data elements comprising the profile data, associated measured signals, simulation types, and associated process control parameters, fabrication attributes, device attributes, and circuit attributes;

wherein the simulation types are characterizations of the one or more fabrication process, device or circuit simulations performed.

37. A system for creating a profile-based simulation data store for an integrated circuit, the system comprising:

a metrology simulator configured to:

generate calculated metrology signals using input profile data;

a device simulator configured to:

simulate one or more devices using the input profile data, the one or more device simulations generating device attributes;

a circuit simulator configured to:

simulate one or more circuits using the generated device attributes from the one or more device simulations as input parameters, the one or more circuit simulations generating circuit attributes;

a simulation data store generator configured to:

create instances of a simulation data store, each simulation data store instance storing data elements comprising the profile data, associated measured signals, simulation types, and associated device attributes and circuit attributes;

wherein the simulation types are characterizations of the one or more device or circuit simulations performed.

38. A system for real-time determination of profile-based simulation information for an integrated circuit, the system comprising:

a query device configured to:

send a query comprising type of inquiry for profile-based simulation data and query given data, and

receive a response to the query;

a simulation data store server configured to:

process the query and

formulate the response to the query; and

a simulation data store configured to:

store instances having data elements comprising profile data, signals, and process control parameters, and fabrication attributes;

wherein the simulation data store server, receiving a query from the query device, accesses selected instances of the simulation data store, the selection of the instances of the

simulation data store determined by the type of inquiry and query given data, formulates the response to the query, and transmits the response to the query device.

39. The inquiry system of Claim 38 wherein the query device is a metrology system and the query given data is a measured diffracted signal generated by the metrology system.

40. The inquiry system of Claim 39 wherein the query given data is the measured diffracted signal and the response to the query comprises interconnect electrical device attributes from the selected instances of the simulation data store.

41. The inquiry system of Claim 38 wherein the query given data are process control parameters comprising focus and numerical aperture and the response to the query are fabrication attributes comprising sidewall angle and top critical dimension from the selected instances of the simulation data store.

42. The inquiry system of Claim 38 wherein the query device, the simulation data store, and the simulation data store server are contained in one logical device.

43. The inquiry system of Claim 42 wherein the one logical device is coupled to one or more integrated circuit fabrication process devices.

44. The inquiry system of Claim 43 wherein the integrated circuit fabrication process device is a lithography unit.

45. The inquiry system of Claim 43 wherein the integrated circuit fabrication process device is a photoresist stripping unit.

46. A computer-readable storage medium containing computer executable code to provide a response to an inquiry regarding profile-based simulation data of an integrated circuit by instructing the computer to operate as follows:

receiving a query from a query device, the query comprising a type of inquiry and query given data;

accessing a selected one or more instances of a simulation data store, the selection determined by the type of inquiry and query given data; and

formulating a response to the query and transmitting the response to the query device;

wherein the simulation data store stores instances having data elements comprising structure profile data, fabrication attributes, signals, and process control parameters.

47. A computer-readable storage medium containing computer executable code to create a profile-based simulation data store for an integrated circuit by instructing the computer to operate as follows:

performing a fabrication process simulation using process control parameters, the fabrication process simulation generating fabrication attributes and structure profile data;

calculating a simulated signals for the structure profile data using a metrology simulator;
and

creating an instance of a simulation data store, the instance of the simulation data store having data elements comprising the structure profile data, the associated fabrication attributes, the simulated signals, and the process control parameters.

48. A computer-readable storage medium containing computer executable code to create a profile-based simulation data store for an integrated circuit by instructing the computer to operate as follows:

simulating one or more devices using a selected set of input parameters, the device simulations generating device attributes, the set of input parameters including profile data corresponding to the one or more simulated devices;

generating calculated signals with a metrology simulator, the metrology simulator using profile data corresponding to the one or more simulated devices; and

creating simulation data store instances, the instances including calculated metrology signals, profile data, simulation types, process control parameters, and fabrication attributes;

wherein the simulation types are characterizations of the one or more simulations performed.

49. A computer-readable storage medium containing computer executable code to create a profile-based simulation data store for an integrated circuit by instructing the computer to operate as follows:

simulating one or more circuits using a selected set of input parameters, a circuit having one or more devices, the circuit simulations generating circuit attributes, the set of input parameters including profile data corresponding to the one or more devices of the simulated one or more circuits;

generating calculated signals with a metrology simulator, the metrology simulator using profile data corresponding to the one or more devices of the simulated one or more circuits; and

creating simulation data store instances, the instances including calculated metrology signals, profile data, simulation types, process control parameters, and circuit attributes;

wherein the simulation types are characterizations of the one or more simulations performed.

50. A method of providing a service for creating and using a profile-based simulation data store for an integrated circuit, the method comprising:

contracting by a client and a vendor, for the client to remunerate the vendor for the use of systems, processes, and procedures to create and use a profile-based simulation data store; and

providing by the vendor to the client access to systems, processes, and procedures to create and use a profile-based simulation data store, the simulation data store storing instances having data elements comprising profile data, metrology signals, process control parameters, and fabrication attributes.

51. A profile-based simulation data store for an integrated circuit, the data store comprising:

one or more instances of a simulation data store, each instance of the simulation data store including profile data, associated metrology signal and one or more simulation data segments;

wherein the metrology signal corresponds to an integrated circuit structure with a profile characterized by the profile data;

wherein each data segment includes simulation type, associated process control parameters or associated simulation input parameters, and associated simulation attributes; and

wherein the associated simulation attributes comprises data determined by the simulation using the process control parameters or the associated simulation input parameters.

52. The simulation data store of Claim 51 wherein the simulation attributes are fabrication process attributes, device attributes, or circuit attributes depending on the simulation type.